NASA SBIR/STTR Technologies

S3.04-9478 - High Duty Cycle, Extended Operation Constant Volume Combustion Engine

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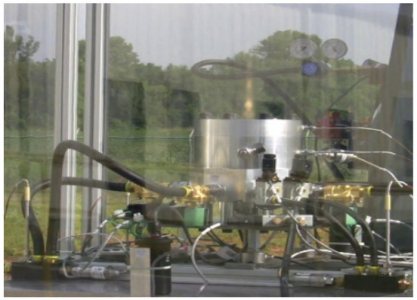
Identification and Significance of Innovation

* NASA's Science Mission Directorate is chartered with answering the fundamental questions requiring the view from and into space.
* Technologies being sought in propulsion include, precision landing, hazard avoidance, in-space rendezvous, and ascent/decent vehicle propulsion.
* This adjustment of mission focus will require propulsion systems that can operate under more demanding conditions, and provide greater flexibility.
* During Phase I we hot fire tested a constant volume (CV) combustion engine and demonstrated the feasibility of this engine cycle.
* The CV engine will provide:
  * Significant weight reduction through lightweight and low pressure fuel and oxidizer storage.
  * System simplification through the elimination of pumps.
  * Improved safety through the use of non-hypergolic fuels.
  * Reduced costs in the system components and ground servicing.



Constant volume combustion engine testing – Note shock diamonds in the plume.

Estimated TRL at beginning and end of contract: (Begin: 4 End: 6)

Technical Objectives and Work Plan

Technical Objectives:
* Increased cycle repetition rate (greater that 10 Hz)
* Increased chamber pressure (over 1000 psi)
* Demonstrate thrust modulation through the use of pulse-width modulation techniques
* Demonstrate the reliability of critical CV engine components to sustained thermal and mechanical operating stresses
* Further develop the scaling/similarity relationships for engine design purposes
* Develop sufficient datasets for performance and mission planning purposes

Work Plan:
* Upgrade of the CV Engine Testbed - Incorporate aerospace grade valves and actuators to increase cycle repetition rate.
* Performance Mapping of the Upgraded Prototype - Map the engine performance to determine ISP and thrust coefficient, among others.
* Definition of Phase II CV Engine Requirements/Design Parameters - Define engine requirements based on notional NASA missions.
* Detailed Modeling and Engineering Analysis - Perform detailed thermal, flow, and stress analysis on the engine.
* Develop and Implement More Sophisticated PLC Controller - Implement closed-loop control and on-board diagnostics.
* Scaling/Similarity Study - Perform a scaling analysis to estimate full-scale engine

NASA Applications

* Orbital maneuvering and station keeping systems for NASA satellites and probes
* Ascent stage propulsion for sample return missions (Mars and asteroid)
* Suitable for any application where there is a need for a propulsion system that needs:
  * A deeply throttable engine,
  * A pulsed mode operation engine,
  * An engine that will experience cold soak without requiring propellant heating, or
  * An alternative to hypergolic propellants.

Non-NASA Applications

* DACS systems on Kinetic Kill Vehicles (KKVs)
* Adaptation for commercial satellites using hypergolic propellants for orbital maneuvering and station keeping
* Alternative to hypergolic bipropellant thrusters

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